Utah Geological Survey
a division of
Utah Department of Natural Resources
in cooperation with
U.S. Geological Survey
STATEMAP Agreement No. 00HQAG109 and 99HQAG0138

PROGRESS REPORT GEOLOGIC MAP OF THE DUTCH JOHN QUADRANGLE (EAST PART)
UTAH-COLORADO-WYOMING
Year 2 of 3

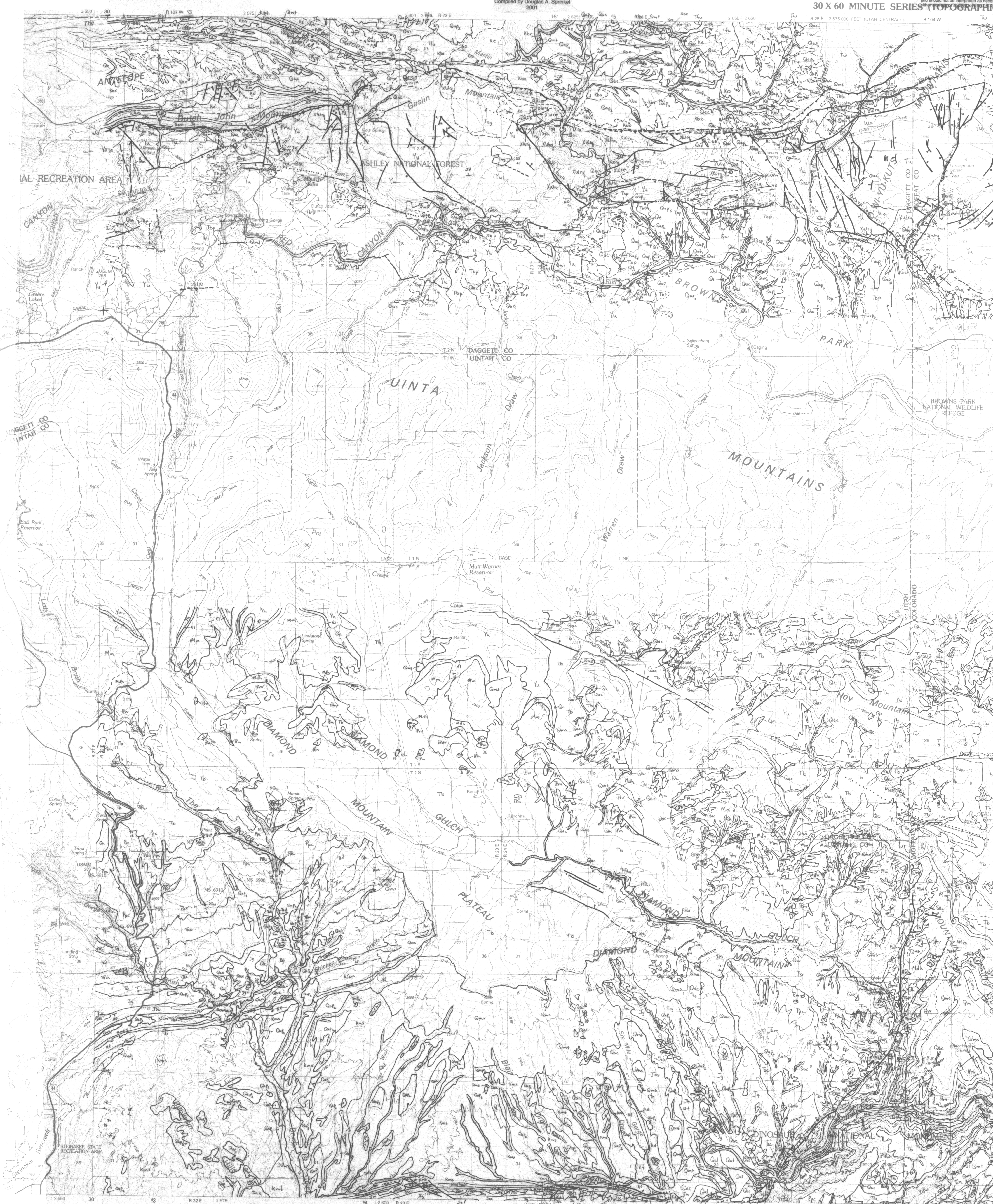
Compiled by Douglas A. Sprinkel
2001

Open-File Report 385
Plate 1

This open-file release is a progress report that provides to the public the results of the second year of mapping on a three-year project. The map is incomplete and inconsistencies, errors, and omissions have not been resolved. This map may not conform to UGS policy and editorial standards, and it may be premature for an individual or group to take action based on the contents.

The views and conclusions contained in this document are those of the author and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. Government.

30 X 60 MINUTE SERIES (TOPOGRAPHIC)



SCALE 1:100 000

1 CENTIMETER ON THE MAP REPRESENTS 1 KILOMETER ON THE GROUND
CONTOUR INTERVAL 50 METERS

DUTCH JOHN, UTAH–COLO.–WYO.
N4030–W10900/30 X 60

Utah Geological Survey
a division of
Utah Department of Natural Resources
in cooperation with
U.S. Geological Survey
STATEMAP Agreement No. 00HQAG109 and 99HQAG0138

PROGRESS REPORT GEOLOGIC MAP OF THE DUTCH JOHN QUADRANGLE (WEST PART)
UTAH-COLORADO-WYOMING
Year 2 of 3

Compiled by Douglas A. Sprinkel
2001

UTAH GEOLOGICAL SURVEY
Open-File Report 385
Plate 2

This open-file release is a progress report that provides to the public the results of the second year of mapping on a three-year project. The map is incomplete and inconsistencies, errors, and omissions have not been resolved. This map may not conform to UGS policy and editorial standards, and it may be premature for an individual or group to take action based on the contents.

The views and conclusions contained in this document are those of the author and should not be interpreted as necessarily representing the official policies, either express or implied, of the U.S. Government.

Utah Geological Survey
a division of
Utah Department of Natural Resources
in cooperation with
U.S. Geological Survey
STATEMAP Agreement No. 00HQAG109 and 99HQAG0138

Progress Report Geologic Map of the Dutch John 30' x 60' Quadrangle, Utah-Colorado-Wyoming

Year 2 of 3

Compiled by Douglas A. Sprinkel

2001

Open-File Report 385

Plate 3

Description of Map Units

Qal Flood-plain alluvium (Holocene) - Unconsolidated silt, sand, and gravel in mostly the Green River flood plain; 1-30 m thick.

Qaf_1 Younger alluvial-fan deposits (Holocene) - Unconsolidated, poorly sorted boulder, gravel, sand, and silt; less than 30 m thick.

Qac Mixed alluvium and colluvium (Holocene) - Unconsolidated mud, silt, sand, and gravel in tributary stream channels of the Green River, along smaller streams, and in other intermittent stream drainages. On the Mancos Shale, this unit is mostly reworked mud; less than 10 m thick.

Qae Mixed alluvium and eolian deposits (Holocene) - Unconsolidated alluvial mud, silt, and sand mixed with well-sorted, fine-grained, windblown sand and silt; less than 10 m thick.

Qe Eolian deposits (Holocene) - Unconsolidated, well-sorted, fine-grained, windblown sand and silt; less than 10 m thick.

Qc Colluvium (Holocene) - Heterogeneous mixture of boulders, gravel, cobbles, sand and silt that may grade into talus, landslide, and alluvial deposits; thin to a few tens of meters thick.

Qmt Talus deposits (Holocene and Pleistocene) - Unconsolidated and unstratified angular rock fragments that accumulate at the base of cliffs. Colluvium may be a significant part of this deposit; less than 5 m thick.

Qat Terrace deposits (Pleistocene) - Unconsolidated to locally cemented silt, sand, gravel, cobbles, and boulders; remnants of alluvial terraces; less than a few tens of meters thick.

Qap_1, Qap_2, Qap_3, Qap_4 Pediment-mantle deposits (Holocene and Pleistocene) - Unconsolidated to moderately consolidated, poorly sorted sand, gravel, cobbles and boulders; weak to strong soil profile developed in all four levels, and calcium carbonate (caliche) developed in upper 1 to 2 m of older deposits; up to four levels are recognized with the topographically highest level being the oldest. Pediment-mantle deposits on the north flank of the Uinta Mountains likely do not correlate with similarly numbered deposits on the south flank; in addition, map unit Qap_3 in Browns Park and unit Qap_2 in the Island Park 7.5-minute quadrangle may represent more than one age of pediment-mantle deposit.

Qaf_2 Older alluvial-fan deposits (Pleistocene) - Dissected, unconsolidated, poorly sorted boulder, gravel, sand, and silt; less than 10 m thick. Only mapped in the Island Park 7.5-minute quadrangle.

Qms Slides, slumps and flows (Holocene and Pleistocene) - Earthflow and rotation slumps and slides in formations prone to slope failure.

Qg Glacial till, undivided (Late Pleistocene) - Unconsolidated, poorly sorted, angular to rounded cobbles and pebbles of red metaquartzite (Uinta Mountain Group) that generally forms small ridges, knolls, and kettles with a smooth to hummocky surface; age of glaciation has not been determined at this time; 1-50 m thick.

Qgo Glacial outwash, undivided (Late Pleistocene) - Unconsolidated, well-rounded, red, metaquartzite cobbles and pebbles and sand derived from the high-energy meltwaters of glaciers of undetermined age; less than 5 m thick.

Qgs Smiths Fork Till (Late Pleistocene) -Unconsolidated, poorly sorted, angular to rounded cobbles and pebbles of red metaquartzite (Uinta Mountain Group) that generally forms small ridges, knolls, and kettles with a smooth to hummocky unmodified surface; Smiths Fork Till is correlated to Pinedale glaciation (Douglass, 2000; Munroe, 2001); 1-50 m thick.

Qgso Smiths Fork outwash (Late Pleistocene) - Unconsolidated, well-rounded, red, metaquartzite cobbles and pebbles and sand derived from the high-energy meltwaters of Smiths Fork-age glaciers (Munroe, 2001); less than 5 m thick.

Qgb Blacks Fork Till (Late Plesitocene) - Unconsolidated, poorly sorted, angular to rounded cobbles and pebbles of red metaquartzite (Uinta Mountain Group) that generally forms slightly modified small ridges, knolls, and kettles with a smooth to subdued hummocky surface; Blacks Fork Till is correlated to Bull Lake glaciation (Douglass, 2000; Munroe, 2001); 1-50 m thick.

Qgbo Blacks Fork outwash (Late Pleistocene) - Unconsolidated, well-rounded, red, metaquartzite cobbles and pebbles with some boulders and sand derived from the high-energy meltwaters of Blacks Fork-age glaciers (Munroe, 2001); less than 5 m thick.

Tng Old gravel deposits (Pliocene to Miocene?) - Unconsolidated to moderately consolidated, poorly sorted boulders, cobbles, pebbles, gravel, and sand that caps high-level erosion surface in Goslin Mountain 7.5-minute quadrangle; clasts consist of chert, limestone, and quartzite; may be correlative with the Browns Park Formation; maximum thickness is about 50 m.

Tbp Browns Park Formation (Miocene) - Light-gray and light-brown, poorly to moderately consolidated, cross-bedded sandstone; some tuffaceous sandstone; subordinate conglomerate, siltstone, and crystal-poor, glassy, rhyolitic air-fall tuff; K-Ar ages of 25 to 10 Ma, but probably no older than 15 Ma (Hansen 1986); 0-500 m thick.

Tb Bishop Conglomerate (Oligocene) - Light-gray to pinkish-gray, poorly sorted, loosely cemented, pebble, cobble, and boulder conglomerate and friable sandstone mapped on the south flank of the Uinta Mountains; clasts are mostly red quartzite (Uinta Mountain Group) with some carbonate (Paleozoic); light-gray tuff interbeds with euhedral biotite and hornblende; K-Ar age of 29 Ma (Hansen, 1986); 150 m thick.

Td Duchesne River Formation (Eocene) - Reddish-brown, yellowish-gray, and greenish-gray lithic sandstone, siltstone, claystone, and conglomerate; contains well-developed paleosols; lower part of formation intertongues with underlying Uinta Formation to the south in the Uinta Basin; 270 m in quadrangle, but more than 1,000 m thick southward in the Uinta Basin .

Tg Green River Formation (Eocene) - Soft to moderately resistant, light- to medium-gray, light- to medium brown, yellow, and greenish-gray mudstone, organic-rich marlstone, siltstone, sandstone, and cherty limestone; lower part intertongues with underlying Wasatch Formation and the upper part intertongues with the overlying Bridger Formation north of Uinta Mountains; 90-250 m thick in the quadrangle, but is much thicker in the basins north and south of the Dutch John quadrangle.

Tw Wasatch Formation (Eocene) - Red, yellow, and gray friable sandstone, siltstone, claystone, and conglomerate; upper part intertongues with overlying Green River Formation in Green River Basin north of Dutch John quadrangle; conglomerate clasts consist of mostly gray limestone (Paleozoic), sandstone (Mesozoic), and some red quartzite (Uinta Mountain Group); 610 m thick.

Tfu Fort Union Formation (Paleocene) - Light-gray, light-brown, light-green, and brown sandstone, shale, and claystone with some carbonaceous shale, coal, siltstone, and conglomerate beds; inverse stratigraphy of Mesozoic through Paleozoic clasts in conglomerate beds with some clasts of Uinta Mountain Group locally present; only mapped on north flank of Uinta Mountains; 365-700 m thick.

TKfz Uinta fault zone rocks (Tertiary and Upper Cretaceous) - Broken rock derived mostly from the hanging wall that range from recognizable rock fragments to cataclasite and gouge; the fault zone varies from a few meters to about one kilometer in width.

Ke Ericson Sandstone (Upper Cretaceous) - Resistant, light-gray, medium- to coarse-grained sandstone and lenses of conglomerate, with local thin beds of dark-gray nonmarine shale; only mapped on north flank of Uinta Mountains; 88-275 m thick.

Krs Rock Springs Formation (Upper Cretaceous) - Resistant, light-gray to pale-grayish-orange, fine-grained, cross-bedded sandstone with some carbonaceous shale and coal beds; only mapped on north flank of Uinta Mountains; 80-333 m thick.

Kbl Blair Sandstone (Upper Cretaceous) - Resistant, light-gray, pale-grayish-orange to pink, thick-bedded sandstone with interbedded gray marine shale; shown as a tongue of the Baxter Shale near the Glades; only mapped on north flank of Uinta Mountains; 0-107 m thick.

Kbx Baxter Shale (Upper Cretaceous) - Gray, soft, slope-forming calcareous shale containing numerous beds of fine-grained, ripple-marked sandstone and minor limestone; only mapped on north flank of Uinta Mountains; 1,890 m thick.

Kms Mancos Shale (Upper Cretaceous) - Main body of the Mancos Shale; dark-gray, soft, slope-forming calcareous shale containing beds of siltstone and bentonitic clay; only mapped on south flank of Uinta Mountains; 1,500 m thick.

Kf Frontier Sandstone (Upper Cretaceous) - Upper part resistant, light-brown to light-gray and yellow, fine-grained and ripple-marked sandstone with local petrified wood and fossils; lower part soft, light- to dark-gray calcareous shale; may include minor limestone and coal beds in the lower part; 52-58 m thick.

Kmd Mowry Shale and Dakota Sandstone undivided (Lower Cretaceous) - These formations are shown as one unit, mostly along the south flank of the Uinta Mountains, because they were too thin to map separately at this scale. See below for descriptions and thickness.

Km Mowry Shale (Lower Cretaceous) - Dark-gray, siliceous shale that weathers silver gray; contains abundant fish scales; 61-67 m thick.

Kd Dakota Sandstone (Lower Cretaceous) - Upper and lower resistant, yellow and light-gray, medium- to coarse-grained sandstone beds separated by a carbonaceous shale; contains coal beds in exposures along south flank of Uinta Mountains; 40-76 m thick.

KJcm Cedar Mountain Formation and Morrison Formation - Cedar Mountain is mapped with the underlying Morrison Formation because it is generally thin and the contact with the underlying Morrison is difficult to determine; total thickness of map unit is 244-287 m.
Cedar Mountain Formation (Lower Cretaceous) - Purple, gray, and greenish-gray mudstone, siltstone, minor sandstone and limestone; contains calcrete beds that weather out as carbonate nodules; 0-60 m thick.
Morrison Formation (Upper Jurassic) - Upper Brushy Basin Member consists of soft, banded, variegated (light-gray, olive-gray, red, and light-purple) shale, claystone, siltstone, and minor cross-bedded sandstone, conglomerate, and bentonite; lower Salt Wash Member consists of resistant, light-gray to white cross-bedded sandstone; Salt Wash Member may not be preserved in the Flaming Gorge area; dinosaur remains are preserved in the Salt Wash Member at Dinosaur National Monument to the southeast; 184-227m thick .

Jm Morrison Formation - Same as Morrison described in map unit KJcm; the upper part of this map unit may also contain beds of the Cedar Mountain Formation; Jm is mapped along the south flank of the Uinta Mountains; 200-300 m thick.

Jsc Stump Formation, Entrada Sandstone, and Carmel Formation
Stump Formation (Upper and Middle Jurassic) - Upper Redwater Member is greenish-gray and light-green slope-forming shale with glauconitic, fossiliferous (belemnites) sandstone and limestone. Lower Curtis Member is resistant, light-gray to greenish-gray, cross-bedded, fossiliferous, glauconitic sandstone, oolitic limestone, and fissile shale. Only the Curtis Member is preserved in the Dutch John quadrangle because of a period of erosion prior to deposition of the overlying Morrison Formation; Stump is 44-55 m thick.
Entrada Sandstone (Middle Jurassic) - Upper reddish-brown siltstone and fine-grained sandstone and a lower light-gray, pink, and light-brown sandstone; lower sandstone is resistant to erosion and forms cliffs and ridges; Entrada is 61-75 m thick.
Carmel Formation (Middle Jurassic) - Medium- to dark-red, green, and gray sandy shale, siltstone, sandstone, limestone and gypsum; upper part is mostly slope-forming red shale, siltstone, and sandstone underlain by a middle gypsiferous unit; lower part is mostly ledge-forming limestone, which is commonly oolitic and fossiliferous; Carmel is 53-101 m thick.

Jg Glen Canyon Sandstone (Lower Jurassic) - Pink, light-gray, and light-brown, resistant, large-scale cross-bedded sandstone; forms cliffs and ridges; top 2-10 m of the formation may include beds of the Middle Jurassic Page Sandstone. It may be more appropriate to call this formation the Navajo Sandstone along the south flank of the Uinta Mountains in the Dutch John 30' x 60' quadrangle. Glen Canyon beds are generally called the Nugget Sandstone along the north flank of the Uinta Mountains; 248-256 m thick.

Ꞩcd Chinle, Moenkopi, and Dinwoody Formations undivided (Upper and Lower Triassic) - Chinle, Moenkopi, and Dinwoody Formations are combined as a single map unit on the north flank of the Uinta Mountains; On previous maps, Chinle beds have been called the Ankareh Formation and the Moenkopi beds have been called the Woodside Shale on the north flank of the Uinta Mountains.
Chinle Formation - Refer to Chinle Formation for description; 91-116 m
Moenkopi Formation - Refer to Moenkopi Formation for description; 221 m thick
Dinwoody Formation - Refer to Dinwoody Formation for description;110-162 m thick.

Ꞩc Chinle Formation (Upper Triassic) - Purplish-red, purple, light-gray, greenish-gray, light-green, ripple-marked siltstone, sandstone, claystone, shale, and conglomerate; generally forms slopes; base is resistant conglomerate unit named the Gartra Member; 50-90 m thick.

Ꞩm Moenkopi Formation (Lower Triassic) - Medium- to dark-red, reddish-brown, green, and gray ripple-marked siltstone, fine-grained sandstone, and shale with gypsum and limestone beds; mostly soft, slope-forming unit; 220-240 m thick.

Ꞩd Dinwoody Formation (Lower Triassic) - Light-gray, greenish-gray, light-brown, and brown, thin-bedded ripple-marked shale, siltstone, and sandstone with minor amounts of limestone. Mostly a soft, slope-forming unit mapped along the south flank of the Uinta Mountains in the Ashley and Brush Creek drainages. The Dinwoody Formation east of the Brush Creek drainage is included in the basal part of the Moenkopi Formation as mapped by Hansen (1977) and Rowley and others (1981). The Dinwoody Formation thins to the west of the Ashley Creek drainage and is represented only by gypsum beds. It is not preserved in and west of the Dry Creek drainage; 30-50 m thick.

Ppc Park City and Phosphoria Formations (Lower Permian) -
Franson Member of Park City Formation - Gray, thick- to thin-bedded cherty limestone and dolomite interbedded with brownish-gray sandstone and red to ochre shale; generally resistant and form ledges and cliffs.
Meade Peak Phosphatic Shale Member of the Phosphoria Formation - Slope-forming dark-gray phosphatic shale with interbeds of sandstone and limestone.
Grandeur Member of Park City Formation - Light-gray to light-brownish-gray sandstone, dolomite, and limestone; generally resistant and form ledges and cliffs.
Combined thickness of Park City and Phosphoria Formations is 73-122 m.

PIPw Weber Sandstone (Lower Permian to Middle Pennsylvanian) - Light-gray to yellowish-gray, very thick bedded sandstone with interbeds of limestone in the lower part; highly cross-bedded sandstone in the upper part; forms steep cliffs and ridges; 472 m thick.

IPMu Pennsylvanian and Mississippian rocks undivided - Small fault blocks of carbonate rocks along the Uinta fault zone.

IPm Morgan Formation (Middle Pennsylvanian) - Light- to medium-red, yellow, and gray shale and siltstone, light- to medium-gray fossiliferous and red cherty limestone, and fine-grained, locally cross-bedded sandstone and red shale; 11-37 m thick.

IPrv Round Valley Limestone (Lower Pennsylvanian) - Light-gray to light-blue-gray, thin- to very thick bedded limestone interbedded with soft red shale; limestone is fossiliferous and cherty; chert is blue gray and yellowish gray, but red to pink jasperoid chert is common in the region; forms ledges and cliffs; 80-127 m thick.

Mdh Doughnut Shale and Humbug Formation
Doughnut Shale (Upper Mississippian) - Dark-gray shale with some red shale near base with beds of coarse sandstone, limestone and coal; shale is slope forming and clayey; 91 m thick.
Humbug Formation (Upper Mississippian) - Light-gray to red, fine-grained to very fine grained, soft to resistant sandstone interbedded with light-gray limestone and red to black shale; sandstone is locally cross-bedded and hematitic near the top of the formation; 75-90 m thick.

Mm Madison Limestone (Upper and Lower Mississippian) - Mostly dark-gray, medium to coarse crystalline, cherty limestone; chert is typically light gray; commonly contains solution cavities; 130-300 m thick.

Ꞓl Lodore Formation (Upper Cambrian) - Light-brown to greenish-gray sandstone underlain by pink to tan to pale-greenish-gray glauconitic shale interbedded with tan to pale-green sandstone; base is variegated (pink, gray, and pale-green) coarse- to medium-grained cross-bedded sandstone; locally pebbly; upper part forms ledges, middle part forms slopes and ledges, and lower part forms cliffs; Lodore pinches out to the west; 0-180 m thick.

Yu Uinta Mountain Group (Upper and Middle Proterozoic) - Dark- to light-red, medium- to coarse-grained, massive to cross-bedded siliceous sandstone (metaquartzite); contains considerable red, green, and gray silty metashale and metaconglomerate; metaquartzite clasts are common in the metaconglomerate; as much as 7,315 m thick.

YXra, XWrq, XWrm, XWre, XWrc Red Creek Quartzite (Middle Proterozoic to Upper Archean) - Contains three main rock types: metaquartzite, mica schist, and amphibolite; other minor rock types include metadiorite and metacarbonate to marble. Map unit as much as 6,096 m thick.
Amphibolite (YXra) - Dark-gray to black, fine- to medium-grained amphibolite composed of strongly foliated to non-foliated metamorphosed mafic rocks, mostly hornblende; intruded into and intimately associated with the Red Creek Quartzite as numerous small bodies in the northeast part of the quadrangle.
Metaquartzite (XWrq) - Resistant white, gray, tan, and light-green metaquartzite.
Mica schist (XWrm) - Quartz-muscovite schist that grades between metaquartzite and mica schist and contains garnet and staurolite.
Metadiorite (XWre) - Metamorphosed diorite; epidiorite of previous mappers.
Carbonate rock (XWrc) - Metamorphosed carbonate rock along Goslin fault.

Wo Owiyukuts Complex (Late Archean) - High-grade, metamorphosed potassium-rich granitic gneiss and lesser quartzofeldspathic gneiss;Rb/Sr age 2,700 Ma; unknown thickness.

Map Symbols

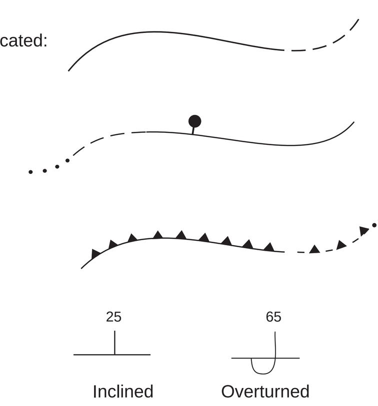
Contacts - dashed where approximately located:

FAULTS

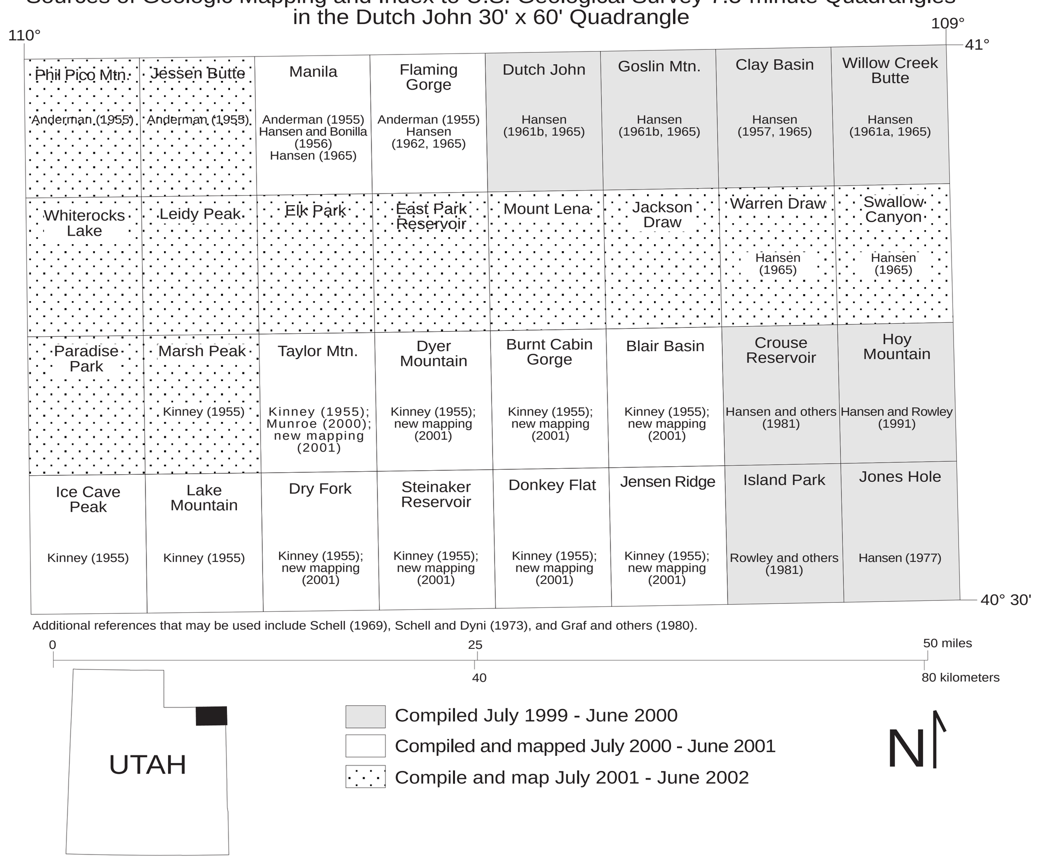
Steeply dipping - Dashed where approximately located; dotted where concealed; bar and ball on downthrown side where offset is known:

Thrust fault - teeth on hanging wall; dashed where approximately located and dotted where concealed:

STRIKE AND DIP OF BEDDING



Sources of Geologic Mapping and Index to U.S. Geological Survey 7.5-minute Quadrangles in the Dutch John 30' x 60' Quadrangle

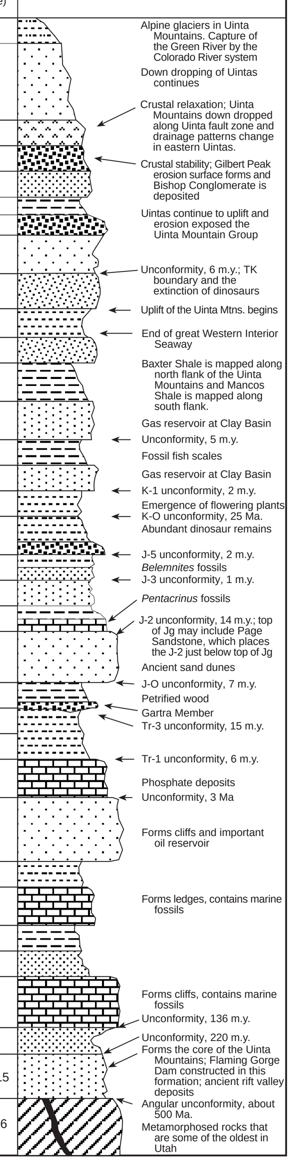


Updated August 6, 2000

Stratigraphic Column

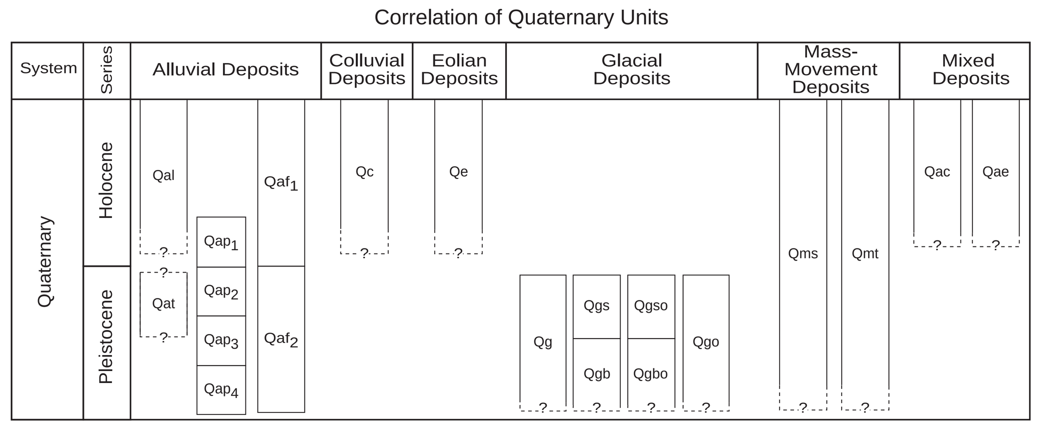
ERATHEM	SYSTEM	SERIES	TIME (MA)	FORMATIONS		SYMBOL	Thickness (meters) (column not to scale)
CENOZOIC	Quat.	Holocene / Pleistocene	1.8	Unconsolidated deposits		Q*	less than 50
	Tertiary	Pliocene	5	Old gravel deposits		Tng	less than 50
		Miocene	24	Browns Park Formation		Tbp	0-500
		Oligocene	34	Bishop Conglomerate		Tb	150
		Eocene		Duchesne River Formation		Td	270-1,000+
				Green River Formation		Tg	90-250
			55	Wasatch Formation		Tw	610
		Paleocene	65	Fort Union Formation		Tfu	365-700
MESOZOIC	Cretaceous	Upper		Mesaverde Group	Ericson Sandstone	Ke	88-275
					Rock Springs Formation	Krs	80-333
					Blair Sandstone	Kbl	0-107
				Baxter Shale; Mancos Shale		Kbx; Kms	1,890; 1,500
			99	Frontier Sandstone		Kf	52-58
		Lower		Mowry Shale		Km (Kmd)	61-67
				Dakota Sandstone		Kd (Kmd)	40-76
			144	Cedar Mountain Formation		KJcm	0-60
	Jurassic	Upper	159	Morrison Formation		KJcm; Jm	244-287
		Middle		Stump Formation		Jsc	44-55
				Entrada Sandstone		Jsc	61-75
			180	Carmel Formation		Jsc	53-101
		Lower	206	Glen Canyon Sandstone		Jg	248-256
	Triassic	Upper	227	Chinle Formation		Ꞩc (Ꞩcd)	91-116
		Lower		Moenkopi Formation		Ꞩm (Ꞩcd)	221
			248	Dinwoody Formation		Ꞩd (Ꞩcd)	0-162
PALEOZOIC	Permian	Lower		Park City and Phosphoria Formations		Ppc	73-122
		Upper	290	Weber Sandstone		PIPw	472
	Pennsylvanian	Middle		Morgan Formation		IPm (IPMu)	11-37
		Lower	323	Round Valley Limestone		IPrv (IPMu)	80-127
	Mississippian	Upper		Doughnut Shale		Mdh (IPMu)	91
				Humbug Formation		Mdh (IPMu)	75-90
		Lower	354	Madison Limestone		Mm (IPMu)	130-300
	CAMBRIAN	Upper	550	Lodore Formation		Ꞓl	0-180
PRE-CAMBRIAN	Proterozoic	Upper / Middle	1,600	Uinta Mountain Group		Yu	as much as 7,315
		Lower	2,500	Red Creek Quartzite and Owiyukuts Complex		YXra XWrq XWrm XWre XWrc Wo	as much as 6,096
	Archean						

LITHOLOGY



*See Correlation of Quaternary Units for symbols

Correlation of Quaternary Units



References

Anderman, G.G., 1955, Geology of a portion of north flank of the Uinta Mountainsin the vicinity of Manila, Summit and Daggett Counties, Utah, and Sweetwater County, Wyoming: Princeton, New Jersey, Princeton University, Ph.D. dissertation, scale1:40,000.

Douglass, D.C., 2000, Glacial History of the West Fork of Beaver Creek, Uinta Mountains, Utah: Madison, University of Wisconsin-Madison, M.S. thesis, 49 p.

Graff, P.J., Sears, J.W., and Holden, G.S.,1980, The Uinta arch project–investigations of uranium potential in Precambrian X and older metasedimentary rocks in the Uinta and Wasatch ranges, Utah and Colorado: U.S. Department of Energy Open-File Report GJBX-170(80), 180 p., scale 1:48,000.

Hansen, W.R., 1957, Geology of the Clay Basin quadrangle, Utah: U.S. Geological Survey Geologic Quadrangle Map GQ-101, scale 1:24,000.

—1961a, Geologic map of the Willow Creek Butte quadrangle, Utah-Colorado: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-322, scale 1:24,000.

—1961b, Geologic map of the Dutch John and Goslin Mountain quadrangle, Utah-Wyoming: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-324, scale 1:24,000.

—1962, Geology of the Flaming Gorge quadrangle, Utah-Wyoming: U.S. Geological Survey Geologic Quadrangle Map GQ-75, scale 1:24,000.

—1965, Geology of the Flaming Gorge area Utah-Colorado-Wyoming: U.S. Geological Survey Professional Paper 490, 196 p., scale 1:48,000.

—1977, Geologic map of the Jones Hole quadrangle, Uintah County, Utah, and Moffat County, Colorado: U.S. Geological Survey Geologic Quadrangle Map GQ-1401, scale 1:24,000.

—1986, Neogene tectonics and geomorphology of the eastern Uinta Mountains in Utah, Colorado, and Wyoming: U.S. Geological Survey Professional Paper 1356, 78 p.

Hansen, W.R., and Bonilla, M.G., 1956, Geology of the Manila quadrangle, Utah-Wyoming: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-156, scale 1:24,000.

Hansen, W.R., Carrara, P.E., and Rowley, P.D., 1981, Geologic map of the Crouse Reservoir quadrangle, Uintah and Daggett Counties, Utah: U.S.Geological Survey Geologic Quadrangle Map GQ-1554, scale 1:24,000.

Hansen, W.R., and Rowley, P.D., 1991, Geologic map of the Hoy Mountain quadrangle, Daggett and Uintah Counties, Utah, and Moffat County, Colorado: U.S. Geological Survey Geologic Quadrangle Map GQ-1695, scale 1:24,000.

Kinney, D.M.1955, Geology of the Uinta River-Brush Creek area, Duchesne and Uintah Counties, Utah: U.S. Geological Survey Bulletin 1007, 185 p., scale 1:63,360.

Kummel, Bernhard, 1954, Triassic stratigraphy of southeastern Idaho and adjacent area [Utah-Wyoming-Montana]: U.S. Geological Survey Professional Paper 254-H, 165-194.

Munroe, J.S., 2001, Late Quaternary history of the northern Uinta Mountains, northeastern Utah: Madison, University of Wisconsin-Madison, Ph.D. dissertation, 398 p.

Rowley, P.D., Hansen, W.R., and Carrara, P.E., 1981, Geologic map of the Island Park quadrangle, Uintah County, Utah: U.S. Geological Survey Geologic Quadrangle Map GQ-1560, scale 1:24,000.

Schell, E.M., 1969, Summary of the geology of the Sheep Creek Canyon Geological Area and vicinity, Daggett County, Utah, *in* Lindsay, J.B., editor, Geologic guidebook of the Uinta Mountains-Utah's maverick range: Intermountain Association of Geologists and Utah Geological Society 16th Annual Field Conference, p. 143-152, scale 1:24,000.

Schell, E.M., and Dyni, J.R., 1973, Preliminary geologic strip maps of the Park City and Phosphoria Formations, Vernal phosphate area, Uintah County, Utah: U.S. Geological Survey Open File Report OFR 73-248, scale 1:24,000.